REMARKS/ARGUMENTS

Favorable reconsideration of this application, in light of the present amendments and following discussion, is respectfully requested.

Claims 20-27 are pending in the present application. Claim 20 is amended. Claims 1-19 are canceled. Claims 21-27 are newly added. Support for the amendment to Claim 20 and newly added Claims 21-27 can be found in the specification as published at least at paragraph [0039] and in Figures 3 and 4. Thus, no new matter is added.

The outstanding Office Action rejected Claim 20 under 35 U.S.C. § 103(a) as unpatentable over Kudo et al. (U.S. Patent No. 6,413,479, herein "Kudo") in view of Miura et al. (U.S. Patent Publication No. 2004/0144029, herein "Miura").

Applicants respectfully traverse the rejection of Claim 20 under 35 U.S.C. § 103(a) as unpatentable over Kudo in view of Miura.

Amended independent Claim 20 recites a method for starting a fuel reforming apparatus. The apparatus includes an assembled unit of a reformer with its associated instruments covered with and enclosed by a vessel that forms a heat insulating layer therearound. The reformer includes a plurality of reformer tubes arranged side by side in a flow path of the combustion gas between the furnace flue and the vessel and is charged with reforming catalysts configured to flow the source gas therethrough for reforming the source gas. The method includes burning startup fuel without a supply of primary fuel to the reformer such that the resultant combustion gas from the burnt startup fuel is heat exchanged with no primary fuel in the reformer. The combustion gas is guided to the flow path while it is still hot and flows around and heats the shift converter and the CO remover.

Applicants have recognized that one benefit of the above-noted feature is a reduced startup time as it does not require a long time to elevate the shift converter and the CO

remover to the required temperatures.[1] Applicants have recognized that another benefit of the above-noted feature is a reduction in height of the reformer through utilization of the multiple reforming tubes and utilization of radiant heat transfer due to high-temperature combustion in the combustor, which allows associated instruments, such as the shift converter and CO remover, to be arranged beneath the reformer.[2]

Turning now to the cited art, Kudo and Miura both describe a reforming apparatus. However, neither Kudo or Miura describe a reformer that includes a plurality of reforming tubes arranged side by side in a flow path of the combustion gas between the furnace flue and the vessel and charged with reforming catalysts configured to flow the source gas therethrough for reforming the source gas. Instead, as shown in Figure 23(A), Kudo describes a reforming reaction unit (2) that comprises a **single** coiled pipe filled with a reforming catalyst.[3] Miura, in Figure 1, describes a reforming catalyst layer (15) disposed in the space between the first cylindrical body (1) and the second cylindrical body (2).[4] Thus, both Kudo and Miura are silent regarding a reformer that includes a plurality of reforming tubes arranged side by side in a flow path of the combustion gas between the furnace flue and the vessel and charged with reforming catalysts configured to flow the source gas therethrough for reforming the source gas.

Moreover, the fuel reforming apparatus of the present invention comprises reactors such as a reformer, water vaporizer, shift converter, and CO remover arranged in order from the top. When the apparatus is started, the reactor disposed at the top is warmed up first, and the lower reactors are gradually warmed up in order. Just before startup, it is preferable that the temperatures reach about 600 °C at the upper part of the reformer, 275 °C at the shift converter, and 150 °C at the CO remover. However, when the operation requires a warm up

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[1] See published application at paragraph [0039].
[2] See published application at paragraph [0038].
[3] See Kudo at column 20, lines 17-18.
[4] See Miura at paragraph [0021].

in a short time or warm startup, the above-noted temperature condition may not be achieved. When the reactor reaches 600 °C, the upper part of the lower shift converter may be heated too much. In such a case, primary water is supplied to the water vaporizer to lower the temperature of the combustion gas at the upper part of the shift converter to thereby control the temperature of the shift converter to the preferred temperature.

In contrast, Miura appears to control the temperature through design of the structure or by determining the operational procedures. Kudo describes various examples to control temperature, such as opening and closing the cover plate to change the direction of the combustion gas flow to reach the proper reaction temperatures at the startup, introducing air from outside to control the combustion gas temperature, and increasing the combustion gas temperature by using an auxiliary burner only at startup. The above-noted constructions and systems in Miura and Kudo are various and complicated. In the present invention, water is supplied only when the temperature of the combustion gas at the upper part of the shift converter is too high at startup and the control process is the same as that in the steady state period. Thus, the invention requires no special control or system.

In addition, most of the reactors in Kudo and Miura are double walled single tube cylinders. The reformer can be heated only from an inner side and the heat transmission area cannot be increased. As discussed above, the reformer of the present invention includes a plurality of reforming tubes with an increased heat transmission area that increases heat transfer efficiency and reduces time for startup.

The shift converter and CO remover in Kudo and Miura are double walled single tube cylinders that are concentrically arranged with the reactor or with each other. Heating is one in three ways: heating by the gas flow through the reforming system (i.e., not heated by combustion gas); one side heating by combustion gas; and double side heating by combustion gas. The heating speed in the reforming gas heating and the one side heating is slower to that

in the present invention. While the double side heating speed is comparable to the present invention, it has the problem of the different temperatures of the combustion gas heating the inner and outer surfaces of the shift converter and the CO remover resulting in non-uniform heating. There is an additional problem of heating the outer surface of the shift converter and the inner surface of the CO remover by combustion gas of the same temperature that results in difficulty of controlling the temperatures of the shift converter and the CO remover individually. In contrast, appropriate heating for the reactors in the present invention can be attained due to the arrangement of the reformer, water vaporizer, shift converter, and CO remover in order from the top.

Kudo, in Figures 23(A), (B) to Figures 27(A), (B), describes reactors that are not double walled single tube cylinders but are helical tubular reactors helically arranged around the combustion chamber. Each of these reactors requires an appropriate amount of catalyst and are prolonged in length to obtain a required capacity. Therefore, the pressure loss of the catalyst is increased. Accordingly, normal atmospheric pressure pumps cannot be used as gas primary fuel feed pumps and CO air feed pumps due to the increased pressure loss of the catalyst. Thus, expensive pumps must be used and auxiliary power for driving the pump is increased, which decreases power generation efficiency.

Furthermore, the vacuum heat insulating layer not only provides an outer heat insulating layer, but also facilitates heat transmission. The reformer in the fuel reforming apparatus must be heated to a temperature of around 600 °C at startup, and the type of heat transmission, such as radiation and convection, from the burner depends of the construction of the fuel reforming apparatus. In Kudo and Miura, the only way to startup heating in a short time is to increase heat flux to the heat transmission area. However, as discussed above, the heat transmission area cannot be increased. Therefore, the heat flux in Kudo and

Miura must be set higher than that of the present invention, which may result in non-uniform heating as the reformer is heated rapidly.

In contrast, the heat transmission area in the present invention is relatively larger that those in Kudo and Miura because of the plurality of reforming tubes. In addition, the radiation heat from the furnace flue reaches not only the surfaces of the reformer tubes neat the furnace flue, but also the surfaces away from the flue by reflection. Thus, radial heat is transmitted evenly all over the reforming tubes to attain uniform heating in a short time.

Moreover, as the hot reactor is disposed at the top and the lower temperature reactors are arranged in order downwardly, each reactor maintains its condition even if the operation is shut down. In other words, the catalyst in the shift converter is not thermally deteriorated. Therefore, restarting can be made under a high temperature condition so that the startup time can be shortened.

In contrast, the reformer in Kudo and Miura is arranged at the bottom or inside concentrically with the insulation layer that covers the top and the peripheral sides. Therefore, when the operation is shut down, the heat of the reformer may be transmitted to the shift converter. In Miura, the exhaust gas is discharged after turning back from the bottom. As a result, the remaining heat from the exhaust gas is discharged from the upper cover plate and exhaust gas outlet such that the fuel reforming apparatus as a whole is rapidly cooled after the operation is shut down. Similarly, in Kudo, the apparatus is rapidly cooled after the invention is shut down, as the exhaust gas outlet is arranged at the top. Thus, restarting in Kudo and Miura is at a low temperature condition.

Furthermore, in the case of an emergency shutdown, the catalyst in the shift converter in Kudo and Miura may suffer thermal deterioration as the heat of the hot reformer may be transmitted to a cold shift converter, as the shift converter is arranged at an outer periphery or upper part of the reformer. In contrast, as the hot reactor is disposed at the top and the lower

temperature reactors are arranged in order downwardly in the present invention, there is reduced thermal deterioration of the catalyst in the shift converter.

Accordingly, no reasonable combination of Kudo and Miura would include all of the features recited in amended independent Claim 20. Therefore, Applicants respectfully request the rejection of Claim 20 under 35 U.S.C. § 103(a) be withdrawn.

Newly added dependent Claims 21-22 each depend from amended independent Claim 20, and patentably distinguish over the cited references for at least the same reasons that amended independent Claim 20 does.

Although differing in scope, new independent Claim 23 includes a recitation of substantially similar features as those discussed above with respect to amended independent Claim 20, and patentably distinguishes over the cited references for at least the same reasons that amended independent Claim 20 does.

Moreover, Claim 23 recites guiding a combustion gas that results from the burning of the startup fuel from the furnace flue to the flow path defined by the interior of the vessel and guiding the combustion gas through the flow path such that the combustion gas flows around an exterior of each of a plurality of reforming tubes that are arranged side by side in the flow path, then flows to the shift converter, and then flows to the CO remover. Both Kudo and Miura are silent regarding the above-noted feature. Instead, Kudo describes:

> [T]he combustion exhaust gas flows from the combustion chamber 1 into the first duct 33 so as to travel upwardly, then deflected at the upper end portion of the first duct 33 so as to travel downwardly within the second duct 34 and discharged to the outside after having again deflected at the lower end portion of the second duct 34 so as to travel upwardly within the third duct.[5]

Miura describes:

> The exhaust gas passage (8) is communicated, at the upper portion thereof, with an outlet (10) of the combustion

[5] See Kudo at column 21, lines 10-17.

> exhaust gas through a space between an upper cover (9) of the exhaust gas passage (8) and an upper cover (13) of a preheating layer (14), from which the combustion exhaust gas is discharged.[6]

Thus, Kudo and Miura fail to disclose or suggest guiding a combustion gas that results from the burning of the startup fuel from the furnace flue to the flow path defined by the interior of the vessel and guiding the combustion gas through the flow path such that the combustion gas flows around an exterior of each of a plurality of reforming tubes that are arranged side by side in the flow path, then flows to the shift converter, and then flows to the CO remover. Accordingly, Applicants respectfully submit that amended independent Claim 23, and Claims 24-27 depending therefrom, further patentably distinguish over Kudo and Miura.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance. An early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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[6] See Miura at paragraph [0020].